Wilson Downing Tributary to West Hickman Creek (WH-2)
Floodplain Analysis

Prepared for:
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Introduction

The Wilson Downing Tributary is 1.28 square mile tributary to West Hickman Creek in southern Fayette County. The Wilson Downing Tributary meets West Hickman Creek just west of the intersections of Wilson Downing and Tates Creek Roads. It extends upstream in a northwesterly direction to New Circle Road in the vicinity of the New Circle Road / Nicholasville Road Interchange. This project involves a comprehensive study of the hydrology and hydraulics for the Wilson Downing Tributary.

The purpose of this study is to document the extent of flooding and evaluate the flood risks for the Wilson Downing Tributary for selected flood events as determined by the Lexington Fayette Urban County Government. While several flood events were analyzed, a primary focus of the study was to determine the level of structure and street flooding for the 25 storm event.

Questionnaires

181 questionnaires were mailed to residents that adjoined the creek. A sample of the questionnaire is contained in Appendix A. The questionnaire asked for basic information about each property and a series of questions directed at identifying any potential flooding issues. 53 responses were returned from the mailing. A summary of the responses can be found in Appendix A. Of the 53 respondents, 7 residents reported flooding of their home or businesses and 3 respondents reported street flooding. After inspection of all the responses, follow up interviews were conducted on site with 6 of the respondents. The results of these follow up interviews is discussed later in the report.

Field Survey

The stream and its floodplain were surveyed via field surveying techniques. The horizontal datum for the survey was based on Kentucky State Plane Coordinate System North Zone. The elevations were based on North American Vertical Datum of 1988 (NAVD 88) using Geoid012.

Stream sections were taken approximately every 200 feet along the stream and all structures crossing the creek were surveyed as well. All pipes and channels entering the creek were surveyed and sizes were noted. All detention outlet structures were surveyed and measured for inclusion into the hydrologic model. A total of 1350 survey shots were taken for the project. Appendix B contains a point listing of the survey shots. Photos were also taken along the stream at selected sections, creek crossings and detention basins. Appendix C contains a photo log that includes stream section pictures. The survey information describe above has been compiled in project maps that are shown in Appendix D.

The Wilson Downing Tributary crosses under 6 city streets and one state route. Each of these is described below. See appendix C for photos of these crossings.

Belleau Wood Drive

The Belleau Wood Drive crossing consists of 74’ long double 84” reinforced concrete pipes. The there is a minimal amount of cover over the pipes. The culverts are at a minor skew to the roadway. The low road elevation for this crossing is approximately 913.0 feet.

Wilson Downing Drive

The Wilson Downing Drive crossing consists of a 22’ single span bridge. The bridge sets on breast wall abutments with wing walls on both the upstream and downstream side. Once the creek passes the bridge, the stream bends sharply to the southeast and parallels Wilson Downing Road. The low road elevation at this crossing is approximately 916.3 feet.

Camelot Drive

The Camelot Drive crossing consists of 105’ long 8’ x 3’ reinforced concrete box culvert and a 36” reinforced concrete auxiliary pipe. The 36” reinforced concrete pipe is located in the left floodplain. The upstream invert of the pipe is approximately 3 foot higher and 35 feet to the left of the box culvert invert. This crossing has approximately 12’ of cover over the box culvert. The low road elevation at this crossing is approximately 942.2 feet.

Lansdowne Drive

The Lansdowne Drive crossing consists of 103’ long 8’ x 4’ reinforced concrete box culvert. The culvert has very limited fill height. The low road elevation at this crossing is approximately 961.9 feet. Two reinforced concrete pipes direct water into the upstream end of the box culvert.

Medlock Road

The Medlock Road crossing consists of a 58’ long 4’ x 4’ reinforced concrete box culvert. The structure has minimal cover with a low road elevation of approximately 972.0 feet over the structure.

Argonne Circle

Wilson Downing Tributary flows under Argonne Circle through a 380’ long 48” reinforced concrete storm sewer. The storm sewer has two bends and crosses under Argonne in the area of the cul-de-sac.

New Circle Road

The New Circle Road crossing consists of a 240’ long 5’ x 4’ reinforced concrete box culvert.   This culvert is not included in the HEC-RAS analysis file.

Hydrology

Hydrologic calculations were performed using the HEC-HMS modeling program. Times of concentration and curve numbers for each sub watershed were determined in accordance with the methods prescribed in the Natural Resources Conservation Service (NRCS) Technical Release Number 55 (TR 55) "Urban Hydrology for Small Watersheds."

The overall watershed was divided into 20 sub watersheds that were combined into a comprehensive watershed model for the tributary. The sub watersheds ranged in size from 8.6 acres to 77.8 acres with average size of 40 acres. Appendix E contains a watershed summary table that shows the each sub watershed. Each sub watershed was divided into flow paths for overland, shallow concentrated and channel flow. Slopes, lengths and roughness values were determined for each segment. Travel times were computed for each of the flow paths for every sub watershed. The total time of concentration (Tc) for each sub watershed was determined by adding these three travel segments together. Details of the Time of concentration values can be seen in Appendix E.

The Soil Conservation Service (SCS) unit hydrograph modeling procedure was used to determined flow rates throughout the tributary. A lag time for each sub watershed's unit hydrograph was initially set at 0.6Tc; however some were adjusted to match field conditions (See Appendix E for a listing of these values).

The NRCS Web Soil Survey was used to analyze the soil types in the watershed. The soils are predominately silty loams that are classified as hydrologic soil groups B and C. See Appendix F for the NRCS soils information. Using the land use types and hydrologic soil group information, weighted curve numbers were calculated for each watershed. The weighted curve numbers for each sub watershed are shown in Appendix E.

Using the hydrologic methods described above, peak flows were calculated at strategic points along the tributary using the HEC-HMS model. The points were selected based on the location of road crossings and at locations where sub reaches entered the main stream. Peak flows were calculated for a 24 hour storm for the 500 year (0.2% annual chance), 100 year (1% annual chance), 50 year (2% annual chance), 25 year (4% annual chance) and 10 year storm (10% annual chance) events. Peak flows were also calculated for a documented storm that occurred on August 31, 2013. During the August 31 storm, 2.32 inches of rain fell in just under 60 minutes. This approximately equates to a 25 year-1 hour storm event. The output from the HEC-HMS modeling for all the storms studied is included in Appendix G

As a comparison, the USGS regional equations were used to calculate the peak flow for the watershed at its confluence with West Hickman Creek and in the area of Lansdowne Drive. The regional equation parameters were determined for the watershed and verified via the United States Geological Survey (USGS) Stream Stats site. A copy of the printout from the Stream Stats Site in included in Appendix H. The stream stats calculation gives flow rates based on the regression equations alone. When a watershed is urbanized, these calculations have to be adjusted to account for the effects of urbanization. The USGS National Streamflow Statistics Program was used to determine the urbanized flow from the watershed. It should be noted that the USGS methodology does not account for manmade detention basins. The results of this analysis are also included in Appendix H.

The calculated flowrates discussed above were also compared to flowrates in the current Flood Insurance Study (FIS) for the Wilson Downing Tributary as well. The current FIS hydrology was based on the 1993 County Wide Fayette County FIS. In the 1993 FIS, the Kirpich equation was used to determine times of concentration and the resulting watershed lags. The Kirpich method was developed for small agricultural watersheds in Tennessee and is based on the average slope and length of the entire watershed. The TR-55 method was developed for urban watersheds and divides the flow paths into 3 segments.

The hydrologic calculations in the 1993 county wide FIS accounted for storage in 3 basins. It is likely that the basins in the Wilson Downing Tributary were not accounted for in the hydrology for this study. This would explain the much lower flow rates calculated for the upper reaches of the watershed determined in this study. A summary comparison of calculated, USGS, and FIS 100 year flows is shown in the table below.

Peak Flow Summary Comparison

Location	**100 Year Calculated (CFS)**	**100 Year USGS (CFS)**	**100 Year FIS (CFS)**	**25 Year Calculated (CFS)**	**25 Year USGS (CFS)**
At West Hickman Creek	1886	1780	1585	1277	1200
At Lansdowne Drive	439	876*	934	311	580*

* Drainage area at this point in the tributary is outside of the range recommended for USGS Regional Equations

A more detailed table of discharges for all for the various return intervals is included in Appendix I. The peak flows shown in the appendix table lists values that correspond to the flow change locations used in the HEC-RAS model.

<u>Hydraulics</u>

The survey data and hydrologic calculations were compiled into a preliminary HEC-RAS model of the entire tributary. 58 sections were developed from the survey data and entered into the HEC RAS model. Additionally, 7 hydraulic structures were surveyed and analyzed in the model. The project maps in Appendix D show the locations of the sections in the HEC RAS model.

Although the Wilson Downing tributary is an urban stream, there are still stretches of the creek that exhibit natural stream conditions. In the upper reaches of the tributary the stream has been channelized to fit between the properties. In many areas, the floodplain of the tributary consist of lawn grass. In these areas, the manning's n values were considerably lower than natural floodplain values. The manning's n values were varied throughout the reach to emulate the conditions on the ground. A listing of manning's values for each section is included in Appendix J. Appendix J also contains HEC-RAS output tables, profiles and sections.

Follow Up Interviews

After a review of the results of the preliminary modeling and the responses from the questionnaires, follow up interview were scheduled with selected residents. The primary purpose of these follow up interviews were to verify initial model results, get a general description of flooding areas and collect information on high water marks. All residents that reported flooding were contacted by phone to determine the extent and cause of the reported flooding. Follow up interviews were conducted with the 7 residents that reported flooding and 2 residents that provided comments relevant to the study.

The primary results of the follow up interviews indicate that there is only one area that is subject to repetitive flooding. This is flooding occurs at the Downing Place Townhomes just below Camelot Drive. A photo of a documented storm is shown in Calibration discussion below.

Two residents (3483 and 3485 Lansdowne Drive) specifically mentioned that since improvements were made to the "basin behind Kmart" flooding levels have been lower. This is basin "Res S17" in the HEC-HMS model. 3485 Lansdowne reported that their resident has not flooded in 29 years. 3483 Lansdowne indicated that since the basin improvements were made they have not flooded either.

3480 Lansdowne reported minor flooding, but it was determined that the resident flooding was a result of sewer backups and/or overland flooding that was not a result of backups in the Wilson Downing Tributary. This resident also reported that Lansdowne Drive does occasionally overtop with a few inches of water in the roadway.

High Water Marks

The follow up interviews produced 6 locations were high water marks were determined to be caused by creek flooding. For most of these high water marks the exact time and date could not be determined. A few of the observations were reported to happen within general time frames; however an inspection of rainfall records determined that most of these observations could not be associated with documented rainfall events. However, the high water mark at Downing Place Townhomes (3395 Spangler Drive) was reported to have occurred on August 31st, 2013. This area is located between stations 4441 and 4639 in the HEC-RAS model. This high water mark is noted on the project maps by its elevation of 925.75 feet and the date of occurrence. The other high water marks are noted on the project maps with their elevations and the difference from the calculated 100 year water surface elevation in parentheses.

Calibration

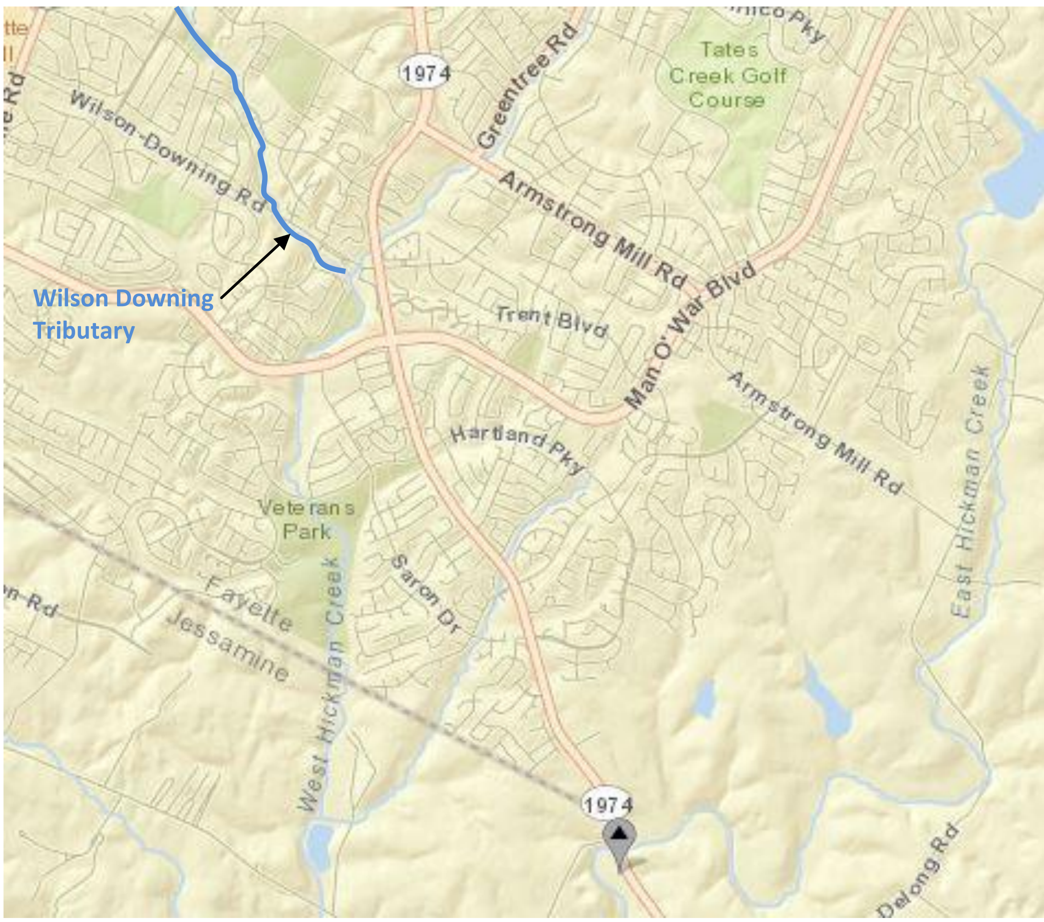
As previously mentioned comparisons were made to the published Flood Insurance Study (FIS) flows and flows calculated from the USGS regional equations. Initially the computed HEC-HMS flows were much higher than the published FIS and USGS regional equations. Once inserted into the HEC-RAS model, the resulting water surface elevations were higher than what was reported in the responses from the questionnaires. Follow up field investigations were performed on all detentions basins and certain critical areas of the watershed. Subsequent to the follow up investigations, some adjustments to flow lengths for overland, shallow concentrated and channel segments were made. There were also some adjustments made to the detention calculations and watershed lag times. The resulting flows were closer to the FIS and USGS numbers. Flows for the lower reaches of the tributary were higher when compared to the FIS and USGS values, while flows in upper reaches were lower than FIS and USGS flows. As stated earlier, the FIS study flows may have not accounted for detention in the watershed. Also, recent modifications made to basin Res S17 have reduced flows in upper portion of the watershed. This would explain why the FIS flows were higher in the upper reaches when compared to the flows calculated in this report. It should also be noted that the watershed size in the upper reaches of the watershed were out of the recommended ranges for the use of USGS equations.

As previously mentioned, the high water mark between river stations 4441 and 4639 was reported to have occurred on August 31st, 2013. This was the only high water mark that could be tied to a specific documented rainfall event. The water surface elevation for this rainfall event was reported to reach the doors of the cars in the parking lot of the Downing Place Townhomes. The picture below was taken after the water had receded slightly from the crest.

August 31, 2013 Flooding Event
Downing Place Townhomes
(Between RS 4441 and 4639)

The crest elevation for this event is estimated to be approximately 925.75 feet. Rainfall records were obtained for this storm from the East Hickman Gage. This gage is located on East Hickman Creek in southern Fayette County as shown in the map below. This gage is located approximately 2.7 miles south of the confluence of Wilson Downing Tributary and West Hickman Creek. The rain gage data was entered into the HEC-HMS model and the resulting flows entered into the HEC-RAS model. The resulting water surface elevation from the HEC-RAS model for this storm is 926.03, which equates well with the high water mark elevation of 925.75 feet.

Another documented rainfall event occurred on September 23, 2006. While there was no rainfall gage data available in close proximity to the Wilson Downing Tributary, there was gage data available for surrounding locations. The surrounding gages reported rainfall amounts that range from a 10 year to a 100 year rainfall event for this storm. Data from LFUCG stream elevation gages indicated that Wilson Downing Drive and Lansdowne Drive flooded during this event.



East Hickman Gage Location

Several factors inhibited the efforts to calibrate the modeling for the project. First and foremost was a lack of information available to tie high water marks to specific documented storms. Also there are no stream gages on the Wilson Downing Tributary and the nearest rain gage is nearly 3 miles away. Since this watershed is relatively small, it would have been desirable to have a rain gage closer to the project. Adjustments were made to modeling criteria in attempt to match more closely what was observed in the field. While the September 31st, 2013 storm modeling results did match well with water surface elevations reported in the field, it would have been beneficial to have more data available for the calibration effort.

Roadway Structure Capacity

The Wilson Downing Tributary flows through 5 city owned roadway structures. As previously mentioned, one of the primary goals of this study was to determine the extent of flooding on city streets in the area. In light of this, it was critical to get information from the residents pertaining to street flooding. One of the questions in the aforementioned questionnaire inquired about street flooding. Three residents reported street flooding. Two of these residents were on Lansdowne Drive and one was on Spangler Drive (See Appendix A2). The results from the HEC-RAS model indicate that most of the roadway structures overtop with many of the storms used in the study. The table below indicates the computed water surface elevation (WSE) at these structures for the various storms used in the study.

Road Structure Flooding Elevations

	Low Road Elev	100 Yr 24 Hr WSE	Δ	25 Yr 24 Hr WSE	Δ	10 Yr 24 Hr WSE	Δ	8/31/13 Storm WSE	Δ
Belleau Wood Drive	913.0	914.56	1.6	913.88	0.9	912.18	-0.8	909.33	-3.7
Wilson Downing	916.3	919.25	3.0	918.73	2.4	918.25	2.0	917.48	1.2
Camelot Drive	942.2	944.16	2.0	943.67	1.5	943.03	0.8	938.73	-3.5
Lansdowne Drive	961.9	962.33	0.4	960.77	-1.1	960.2	-1.7	959.49	-2.4
Medlock Road	972.0	973.32	1.3	973.19	1.2	972.73	0.7	971.58	-0.4

Roadway Overtops

Structure Conveys Flow Without Overtopping